

Sir Ian Axford and the Study of Comets

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Even though comets were not Sir Ian Axford's main field of research, his scientific contribution was crucial to its development. When the existence of the collisionless bow shock of Earth's magnetosphere because of interaction with the supersonic solar wind was just discovered in the early 1960s, Sir Ian had the foresight in predicting the possible existence of a similar structure in comets (Planet. Space Sci., 12, 719, 1964). This work might be considered as the pathfinder of the theoretical studies raging in the 1970s. It also provided the ground work for his initiation of the daring Giotto mission to comet Halley which was the first planetary mission of European Space Agency. Two major findings from Giotto measurements concerning cometary plasma dynamics also carried Sir Ian's signature. The first one has to do with the acceleration of ions in the extended coma regions of comet Giacobini-Zinner and comet Halley. The formation of a weak shock because of mass-loading effect makes the diffusive shock acceleration not very efficient. Instead, the presence of large abundance of plasma wave turbulence leads to stochastic acceleration via the Fermi II mechanism. It was the first time when Fermi II acceleration was studied in astrophysical environment. A simple analytical model was developed to demonstrate this point (Ip and Axford, Planet. Space Sci., 34, 1061, 1985). The second one deals with the formation of the diamagnetic cavity in the inner ionosphere of comet Halley (and other comets). The force balance argument utilizing the equilibrium between neutral gas frictional force and the $\mathbf{J} \times \mathbf{B}$ force of the draped magnetic field was first presented in 1982 and confirmed by Giotto's deep entry into the inner coma of comet Halley in 1986 (Ip and Axford, Nature, 325, 418, 1987). The background and scientific considerations of these works will be presented.